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ENVIRONMENT CANADA
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MARINE MONITORING AT CAPE LAZO, B.C.
MARINE SEWAGE OUTFALL:

MARCH 1985 UPDATE AND TREND ANALYSIS

Regional Program Report 86-20

By

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ABSTRACT

Sediments and water were sampled in the vicinity of the (Comox) Cape Lazo, B.C. submarine sewage outfall on 11 March 85 . A reference site 5 nautical miles away was also sampled.

The water column at the outfall and the reference site was unstratified. Temperature ranged from 7.8 - 7.9°C, while salinity was uniformly 29.7 ppt. Dissolved oxygen ranged from 7.0 to 8.9 mg/L (74 -93 % saturation).

Nutrients (NH3, NO2, NO3, o-PO4, t-PO4) were not elevated at the outfall site, when compared to baseline and reference site data.

Sediment nickel, lead, and hydrocarbons were all below detection limits. Sediment fecal coliforms were at or below the limit of detection (200 mpn/100 g sediment).

The increase in sediment volatile residue noted in the summer of 1984, was apparently due to seasonal fluctuations. Levels detected in winter 1985 are comparable to the winter 1979 concentrations.

In summary, no significant impact of the outfall on water or sediment quality was detected after about one year of sewage discharge.

Keywords: marine environmental quality, sewage outfall, dissolved oxygen, nutrients, sediment metals, fecal coliform bacteria, time series analysis

RÉSUMÉ

Des échantillons de sédiment et d'eau furent collectés près de l'émissaire marin du Cape Lazo (Comox) le 11 mars 1985. Un site de référence situé 5 miles nautiques de là fut aussi échantillonné.

Les colonnes d'eau à l'émissaire marin ainsi qu'au site de référence étaient non-stratifiées. La température variait de 7.8 à 7.9 C, tandis que la salinité était uniforme à 29.7 parties par mille. L'oxygène dissous variait de 7.0 a 8.9 mg/L (74 - 93 % saturé).

Les substances nutritives (NH3, NO2, NO3, o-PO4, t-PO4) n'étaient pas élevées à l'émissaire marin comparées aux valeurs obtenues au site de référence et avant l'installation de l'émissaire marin.

Les niveaux de nickel, de plomb et des hydrocarbures dans les sédiments étaient tous au-dessous des limites de détection. Les niveaux de bactéries coliformes dans les sédiments étaient égaux ou sous la limite de détection (200 NPP/100 g de sédiment).

L'augmentation des valeurs de résidu volatil dans les sédiments observée en été 1985 était apparemment due aux variations saisonnières. Les niveaux obtenus en hiver 1985 sont comparables aux niveaux de l'hiver 1979.

En résumé, aucun impact signifiant de l'émissaire marin ne fut detecté sur la qualité de l'eau et des sediments après un an de décharge d'eaux usées.

Mots-clés: qualité de l'environnment marin, émissaire marin, eaux usées, oxygène dissous, substances nutritives, métaux dans les sédiments, bactéries coliformes fécales, analyses de temps en série.

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1 INTRODUCTION

This report presents results of the third environmental monitoring survey at the Cape Lazo submarine sewage outfall. Water and sediment samples were collected 11 March 1985 to describe winter water-column and benthic conditions at the outfall for comparison to previously obtained data. At the time of sampling, secondary treated effluent had been discharged for about a year.

Baseline data were collected at the site by the Environmental Protection Service (EPS) in December 1978 and November 1979 (Holman et al., 1981). Local oceanographic and fisheries resource information has been reviewed in Colodey 1984.

Data collected after two months of sewage discharge indicated a slight elevation of ammonia in seawater at 25 m depth (Colodey, 1984). A large increase in sediment organic carbon levels was noted between 1979 and 1984, however seasonal influences could not be excluded because sediment baseline data were collected in November 1979 and the post-discharge data in June 1984 due to ship scheduling constraints.

The present sampling in March 1985 was designed to determine if the apparent rise in sediment volatile residue values was due to seasonal or anthropogenic factors. Other studies have shown that sediment volatile residue often increases in the vicinity of a sewage outfall (Pomeroy, 1984), and can result in changes to the resident benthic invertebrate and fish communities (Spies, 1984).

2 METHODS

Since time on site at Cape Lazo was limited, only five stations nearest the outfall were sampled (Table 1, Figure 1, Appendix 1). Three previously sampled stations (CO-4, 5, 17) were re-sampled, and one new station (CO-21) was added to provide a station south of the outfall. A control, or reference station (CO-22) was added about 5 nautical miles N.W. of the outfall.

TABLE 1 CAPE LAZO SAMPLING STATIONS AND SAMPLES TAKEN 11 MARCH 85

STATION	DEPTH	WATER			SEDIMENT			
CO-	(m)	CTD [1]	DO [2]	NUT [3]	SVR/OG [4]	TM [5]	HYC [6]	BACT [7]
5	63	X	X	X	X	X	X	X
4	64		X	X	X	X	X	X
17	80		X	X	X	X	X	X
21	64		X	X	X	X	X	X
22	63	X	X	X	X	X	X	X

[1] CTD: Conductivity (Salinity), Temperature, Depth
[2] DO: Dissolved Oxygen
[3] NUT: Nutrients: ortho/total phosphate, nitrate, nitrite, ammonia
[4] SVR/OG: Sediment volatile residue, oil and grease
[5] TM: Total metals and mercury
[6] HYC: Hydrocarbons
[7] BACT: *E. coli* bacteria

Samples were collected from the C.S.S. VECTOR using standard oceanograhic methods and equipment: N.I.O. water bottles, 0.1 m^2 Smith-MacIntyre grab, and a Plessy Instruments Conductivity-Temperature-Depth (CTD) unit. Detailed methods are described in Colodey (1984).

Sediment samples for bacterial testing were collected in duplicate, using pre-sterilized plastic spoons, placed in whirl-pak bags, then stored in a cooler. All other sediment samples were collected in duplicate then immediately frozen in paper sediment bags prior to analysis at the EPS/DFO West Vancouver Laboratory according to methods described in Swingle and Davidson (1979).

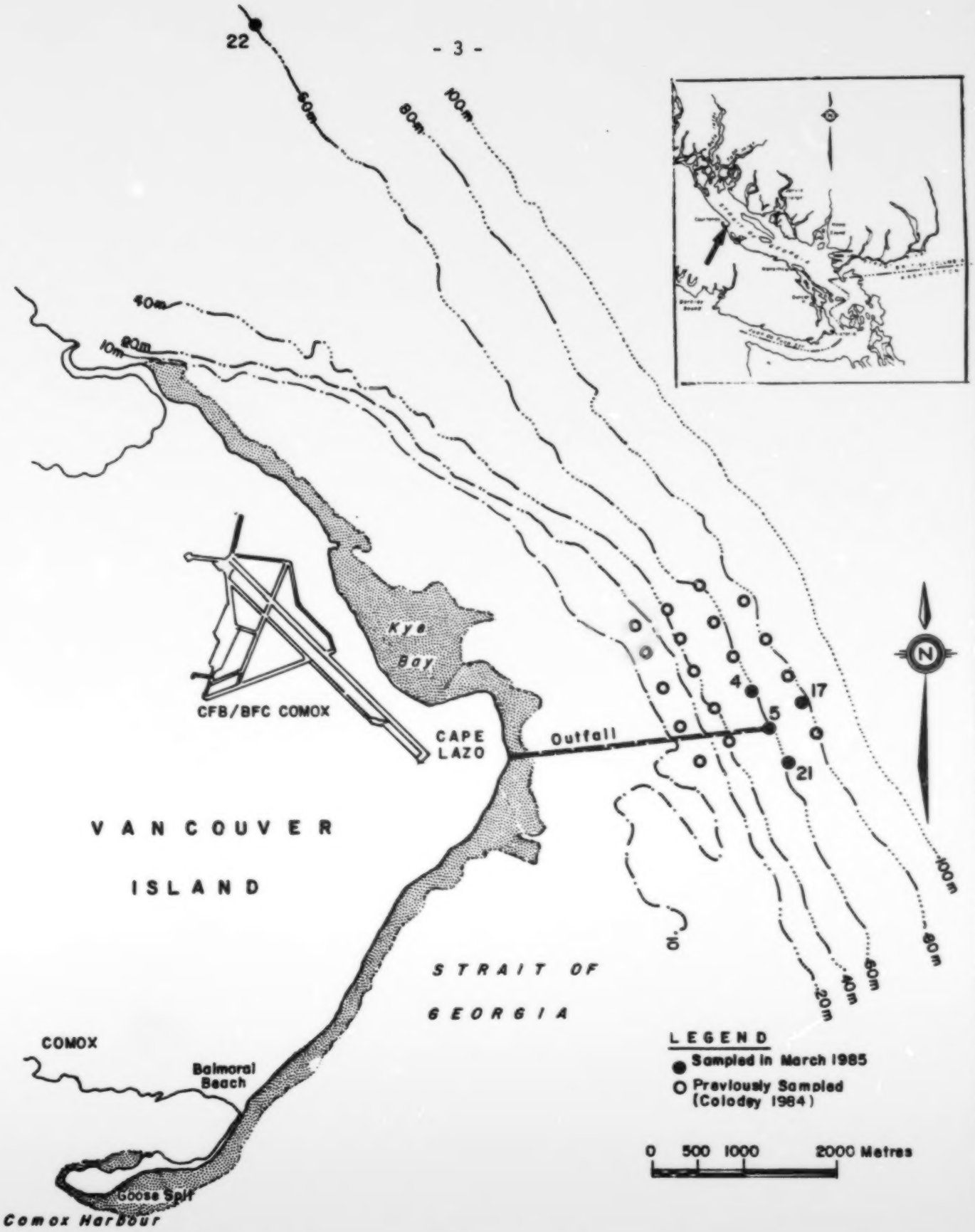


FIGURE 1 SURVEY AREA - MARCH 11, 1985

Frozen sediment samples were freeze-dried and sieved through a 100-mesh nylon sieve. They were then digested in a 4:1 nitric-hydrochloric acid mixture and analyzed for trace metals using a Perkin-Elmer Inductively-Coupled Argon Plasma (ICAP) Optical Emission Spectrometer. Low-level cadmium levels were obtained using a Jarrel Ash 850 Atomic Absorption Spectrophotometer (AAS) with a FLA 100 graphite tube furnace.

Water samples for colorimetric nutrient analysis were frozen immediately after collection. Dissolved oxygen samples were processed on-board using the azide modification of the Winkler method and the percent saturation was calculated using the equation outlined in Gameson and Robertson (1955).

2.1 Data Analysis

Sediment data was transformed (Log x+1) and subjected to ANOVA (analysis of variance). Multiple comparisons were then performed using Tukey's HSD test (Zar, 1984). Statistics were done on a Hewlette-Packard HP9826 using the HP STATISTICAL LIBRARY (1982 Edition).

3 RESULTS AND DISCUSSION

3.1 Water Samples

3.1.1 Temperature, Salinity and Dissolved Oxygen. CTD profiles indicated unstratified conditions throughout the water column at stations CO-5 (outfall area) and CO-22 (control site):

temperature 7.8-7.9°C
salinity 29.7 ‰

Dissolved oxygen (D.O.) data is found in Table 2. D.O. ranged from 7 to 8.9 mg/l (74-93 % saturation). The lowest values at all stations were obtained from near-bottom water samples, perhaps indicating sediment oxygen demand. The regression coefficient ($r = -0.90$; $p < 0.1$) supports this hypothesis and indicates there is a negative relationship between mean organic content of surficial sediments and near-bottom water percent D.O. saturation. The control site had the lowest D.O. (7 mg/l) at 60 m. These values are environmentally acceptable to marine life and are similar to those obtained by Holman et al. (1981) before the outfall was installed.

TABLE 2 TEMPERATURE, SALINITY, DISSOLVED OXYGEN AND PERCENT SATURATION DATA

DEPTH (m)	SALINITY (ppt)	TEMPERATURE (°C)	DISSOLVED OXYGEN (ppm)	% SATURATION	STATION
0	29.7	7.8	8.6	90	CO-21*
5	29.7	7.8	8.6	90	
10	29.7	7.8	8.6	90	
25	29.7	7.8	8.4	88	
50	29.7	7.8	7.9	82	
55					
60					

* no CTD profile: temperature and salinity data from CO-5

CONTINUED...

TABLE 2 (Continued)

DEPTH (m)	SALINITY (ppt)	TEMPERATURE (°C)	DISSOLVED OXYGEN (ppm)	% SATURATION	STATION
0	29.7	7.8	8.7	91	CO-5
5	29.7	7.8	8.7	91	
10	29.7	7.8	8.7	91	
25	29.7	7.8	8.7	91	
50					
55	29.7	7.8	8.2	86	
60					
0	29.7	7.8	8.8	92	CO-4*
5	29.7	7.8	8.8	92	
10	29.7	7.8	8.6	90	
25	29.7	7.8	8.6	90	
50	29.7	7.8	7.9	88	
55					
60	29.7	7.9	8.4	88	
0	29.7	7.8	8.9	92	CO-22
5	29.7	7.8	8.5	89	
10	29.7	7.8	8.6	90	
25	29.7	7.8	8.6	90	
50	29.7	7.8	7.9	88	
55					
60	29.9	8.1	7	74	

* no CTD profile: temperature and salinity data from CO-5

3.1.2 **Nutrient Analysis.** Table 3 presents data on nutrient levels sampled at various depths around the outfall and at the control site. Nitrite was undetectable (< 0.005 mg/l) at all stations and all depths. Data from the control site (CO-22) show that nitrate, ortho and total phosphates were slightly higher at the control site than at the outfall stations. Ammonia was only slightly above detection limits at CO-21, south of the outfall, and CO-5 at the outfall (Figure 2). The maximum concentration

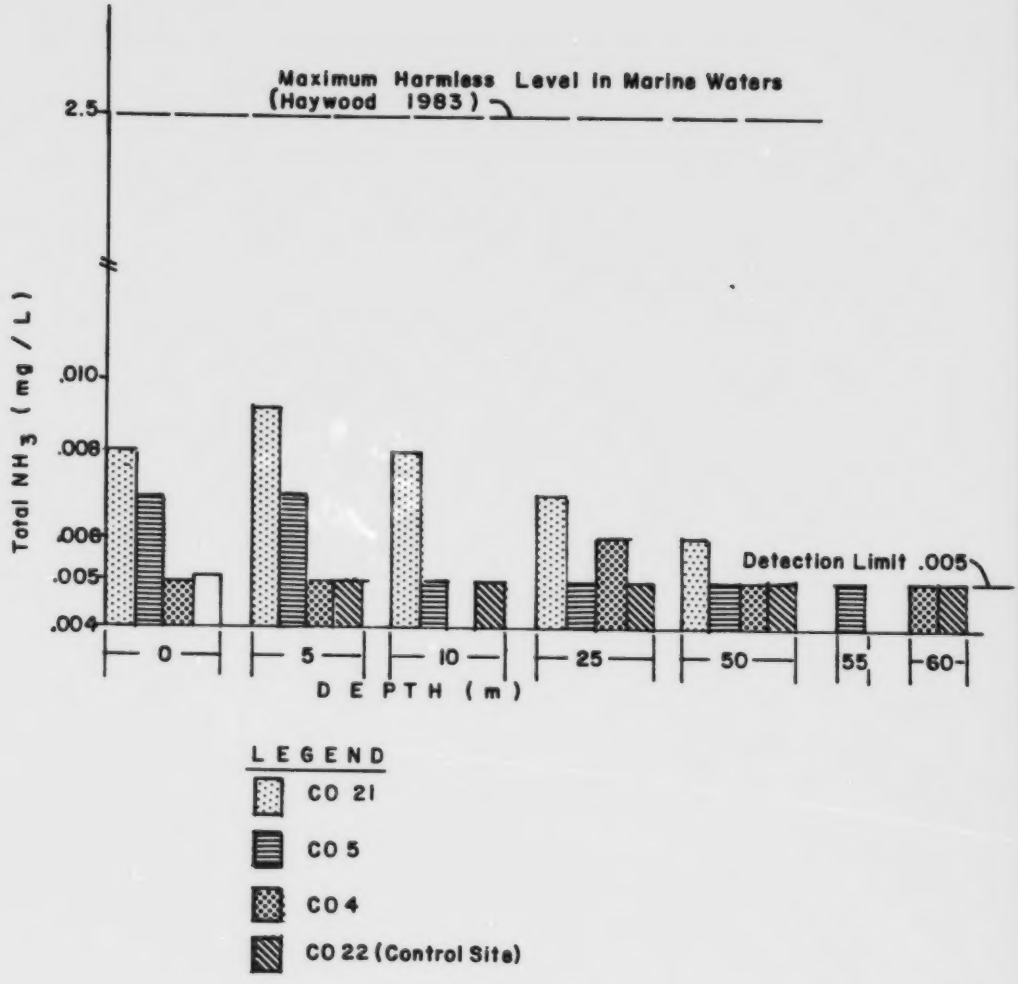


FIGURE 2 AMMONIA DATA, MARCH 11, 1985

sampled (0.009 mg/l at 5 m) was similar to the baseline values reported by Holman et al. (1981). It is well below the concentration of total ammonia (2.5 mg/l) that would impair marine water quality (Haywood, 1983). In fact the nutrients in the effluent may act as a fertilizer and increase primary productivity in the vicinity by 2 to 3 times the seasonal average (Eppley et al., 1972).

TABLE 3 CAPE LAZO NUTRIENT DATA 11 MARCH 1985 (mg/l)

SOUTH OF OUTFALL						
STATION CO-21	DEPTH					
	0	5	10	25	50	Mean
NH_3	.008	.009	.008	.007	.006	.008
NO_2	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
NO_3	.32	.33	.32	.32	.31	.320
$O\text{-}PO_4$	.072	.066	.067	.067	.062	.067
$T\text{-}PO_4$	.083	.069	.075	.068	.070	.073
OUTFALL STATION						
STATION CO-5	DEPTH					
	0	5	10	25	55	Mean
NH_3	.007	.007	< 0.005	< 0.005	< 0.005	.007
NO_2	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
NO_3	.33	.34	.35	.32	.27	.322
$O\text{-}PO_4$	.058	.056	.730	.066	.060	.194
$T\text{-}PO_4$	.072	.063	.087	.074	.063	.072
NORTH OF OUTFALL						
STATION CO-4	DEPTH					
	0	5	10	25	60	Mean
NH_3	< 0.005	< 0.005		0.006	< 0.005	.006
NO_2	< 0.005	< 0.005		< 0.005	< 0.005	< 0.005
NO_3	.34	.30		.34	.30	.320
$O\text{-}PO_4$	.072	.068		.073	.065	.070
$T\text{-}PO_4$	.085	.074		.073	.065	.074

TABLE 3 CAPE LAZO NUTRIENT DATA 11 MARCH 1985 (mg/l) (Continued)

CONTROL SITE						
STATION CO-22	DEPTH					
	0	5	10	25	60	Mean
NH_3	.005	< 0.005	< 0.005	< 0.005	< 0.005	.005
NO_2	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
NO_3	.34	.30	.35	.34	.36	.338
$O\text{-}PO_4$	.072	.068	.071	.073	.082	.073
$T\text{-}PO_4$	.085	.074	.070	.073	.082	.077

3.2 Sediment Samples

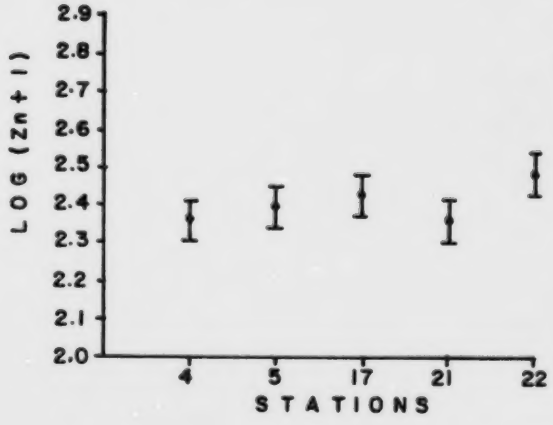
3.2.1 **March 1985 Data.** Selected sediment data collected 11 March 85 are presented in Table 4. Two field replicates (a, b) were taken at each station. Lab duplicates were also occasionally done (aa, or bb). Only those elements previously reported (Holman et al., 1981; Colodey, 1984) are discussed. Complete elemental analysis are listed in Appendix II. Maximum concentrations of each sediment parameter are printed in bold-face type (Table 4).

Nickel and lead were below detection limits (< 3 ppm) at all stations, although a trace of nickel (3-4 ppm) was reported at the control site. Hydrocarbons were also not detected at any station. Bacterial contamination was at the limit of detection at station CO-17 (200 coliforms/100 g) and undetectable elsewhere.

Mercury, cadmium, aluminum, and oil and grease were all marginally higher at the outfall area, in particular at station CO-21. However, mercury and cadmium were highly variable at both the control and outfall sites. Cadminum had a coeficient of variation of 14 to 17%. The extreme variability of cadmium is noted at CO-21 where it ranged from undetectable, to the maximum concentration found. A similar range from undetectable to maximum

TABLE 4 SELECTED SEDIMENT PARAMETERS (mg/kg dry wt. unless otherwise indicated)

STATION	DEPTH (m)	AL (%)	CD	CR	CU	FE (%)	HG	MN	NI	PB	ZN	SVR (%)	OIL & GREASE	COLIFORMS (#)
4a	63	.97	.11	17.5	13.9	1.84	.086	214	< 3	< 3	23.6	1.37	167	< 200
4aa	-	.97	.11	17.7	13.8	1.88	.082	215	< 3	< 3	23.8	-	-	-
4b	62	1.02	.09	16.8	12.2	1.69	.080	232	< 3	< 3	22	1.40	< 100	-
5a	60	1.17	.09	18.4	13.3	1.87	.112	242	< 3	< 3	24.1	1.51	< 100	< 200
5b	60	1.18	.10	20	14.2	2.06	.093	300	< 3	< 3	25.1	1.16	155	-
17a	82	1.22	.09	19.7	15.5	2.05	.107	307	< 3	< 3	29.1	1.59	< 100	200
17b	77	1.89	< 0.08	18.6	13.5	1.90	.086	283	< 3	< 3	24.6	1.38	< 100	-
21a	63	1.72	.14	15.7	13.1	1.72	.126	244	< 3	< 3	22.8	1.83	< 100	< 200
21aa	-	1.89	.11	18.2	15.7	1.89	-	250	< 3	< 3	24.7	-	-	-
21b	54	1.87	< 0.08	18.1	12.1	1.87	.083	267	< 3	< 3	22.4	1.29	< 100	-
22a	65	1.39	.08	21.9	15.7	2.50	.066	371	< 3	< 3	30.8	1.38	159	< 200
22b	66	1.25	.12	18.7	15.9	1.99	.086	300	3	< 3	29.4	1.88	110	-
22bb	-	1.31	.10	19.3	16.8	2.08	.089	313	4	< 3	31.2	-	-	-
OUTFALL SITE														
CO 4-21														
Means	65.1	1.39	.11	18.1	13.7	1.88	.095	255			24.2	1.44	161	
SD	9.4	.40	.02	1.27	1.20	.12	.02	33.1			1.99	.20	8.5	
CV (%)	14	29	16	7	9	6	17	13			8	14	5	
CONTROL SITE														
CO-22														
Means	66.5	1.32	.10	20.0	16.1	2.19	.080	328			30.5	1.63	135	
SD	.7	.07	.02	1.70	.59	.27	.01	37.80			.95	.35	34.6	
CV (%)	1	5	20	9	4	12	16	12			3	22	26	
MEANS SUMMARY														
CO 4	63	.99	.10	17.3	13.3	1.80	.083	220			23.1	1.39	167	< 200
5	60	1.18	.10	19.2	13.8	1.97	.103	271			24.6	1.34	155	< 200
17	80	1.56	.09	19.2	14.5	1.97	.097	295			26.9	1.49	< 100	200
21	59	1.03	.13	17.3	13.6	1.83	.105	254			23.3	1.56	< 100	< 200
22	66	1.32	.10	20.0	16.1	2.19	.080	328			30.5	1.63	135	< 200



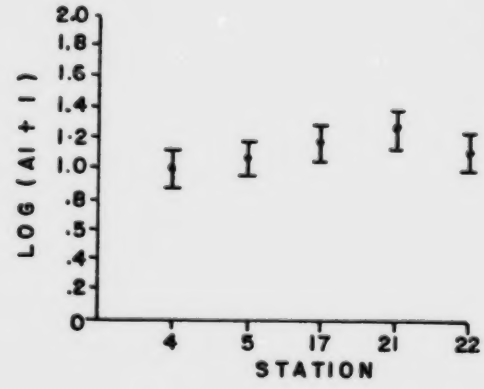
TUKEY'S HSD

Error Mean Square - .0008
Degree of Freedom - 5
Harmonic Average Sample Size - 2.0000
Alpha Level - .05
Table Value from Studentized Range - 5.67
HSD Value - .1116

MULTIPLE COMPARISONS ON STATIONS

Station	Mean	Sample Size	Separation
C04	2.35859	2	a
C021	2.36296	2	a
C05	2.39085	2	ab
C017	2.42866	2	ab
C022	2.48500	2	b

FIGURE 3 TUKEY'S MULTIPLE COMPARISON FOR 1985 SEDIMENT ZINC DATA



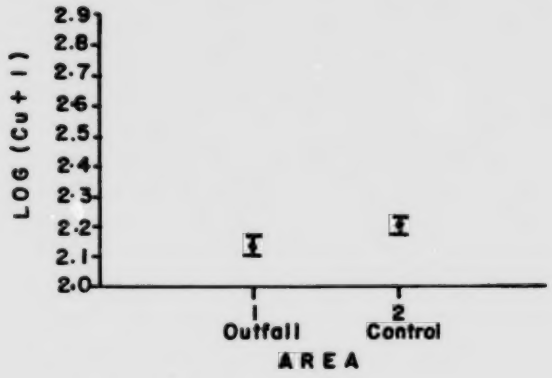
TUKEY'S HSD

Error Mean Square - .0038
Degree of Freedom - 5
Harmonic Average Sample Size - 2.0000
Alpha Level - .05
Table Value from Studentized Range - 5.67
HSD Value - .2476

MULTIPLE COMPARISONS ON STATIONS

Station	Mean	Sample Size	Separation
C04	.997686	2	a
C05	1.070034	2	ab
C022	1.125112	2	ab
C017	1.181411	2	ab
C021	1.264159	2	b

FIGURE 4 TUKEY'S MULTIPLE COMPARISON FOR 1985 SEDIMENT ALUMINUM DATA



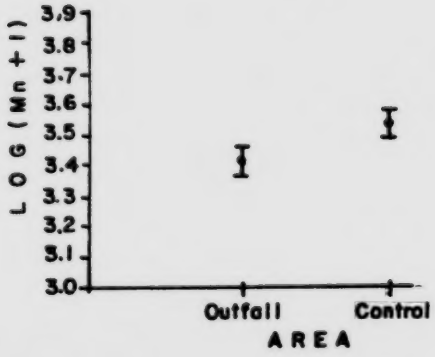
TUKEY'S HSD

Error Mean Square - .0008
Degrees of Freedom - 8
Harmonic Average Sample Size - 3.2000
Alpha Level - .05
Table Value from Studentized Range - 3.26
HSD Value - .0526

MULTIPLE COMPARISONS ON OUTFALL

Area	Mean	Sample Size	Separation
Outfall	2.1	8	a
Control	2.2	2	b

FIGURE 5 TUKEY'S MULTIPLE COMPARISON FOR 1985 SEDIMENT COPPER - OUTFALL VERSUS CONTROL



TUKEY'S HSD

Error Mean Square - .0026
Degrees of Freedom - 8
Harmonic Average Sample Size - 3.2000
Alpha Level - .05
Table Value from Studentized Range - 3.26
HSD Value - .0933

MULTIPLE COMPARISONS ON AREA

Area	Mean	Sample Size	Separation
Outfall	3.408152	8	a
Control	3.527902	2	b

FIGURE 6 TUKEY'S MULTIPLE COMPARISON FOR 1985 SEDIMENT MANGANESE - OUTFALL VERSUS CONTROL

concentration was observed for sediment oil and grease at station CO-4. Variability of data reflects sediment heterogeneity and lab variability. Hence no further analysis was done for mercury, cadmium, or sediment oil and grease.

Data was analysed to determine the magnitude of the differences found between stations. Table 5 summarizes the results of the ANOVA and Tukey's multiple comparisons of sediment parameter means. Only zinc and aluminum were significantly different ($p < 0.05$), when the 1985 levels for sediment metals were compared between stations (Figures 3 and 4). Zinc was elevated at the control site CO 22 compared to stations CO 4 and CO 21, but not different from stations CO 5 and CO 17. Similarly aluminum was significantly higher at CO 21 compared to CO 4, but not different from stations CO 5, 17, 22.

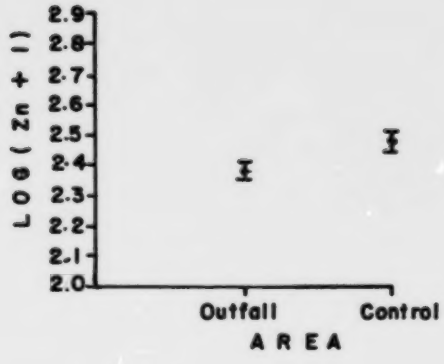
Values obtained at the outfall stations (CO 4, 5, 17, 21) were then pooled for comparison to the control site (CO 22). Copper, manganese, zinc and iron were significantly higher at the control site ($p < 0.05$) (Figures 5-8). No other significant differences were detected.

TABLE 5 SUMMARY OF ANOVA AND TUKEY MULTIPLE COMPARISON SIGNIFICANCE TESTS ($p < 0.05$)

PARAMETER	11 MARCH 1985 DATA		TIME SERIES 1979-1985
	All Stations	Outfall VS Control	CO 4 and 5
Copper	NSD*	CO22 > CO4,5,17,21	NSD*
Manganese	NSD*	CO22 > CO4,5,17,21	NSD*
Zinc	CO22 > CO4, CO21	CO22 > CO4,5,17,21	NSD*
Aluminum	CO21 > CO4	NSD*	NSD*
Mercury	NSD*	NSD*	NT
Iron	NSD*	CO22 > CO4,5,17,21	NSD*
SVR	NSD*	NSD*	1984 > 1979, 1985

* No Significant Difference in means
NT - no test as data not replicated 1979, no 1984 data

3.2.2 Time Series Analysis 1979-1985. Only stations CO-4 and CO-5 have been examined for three sampling periods. Colodey (1984) previously



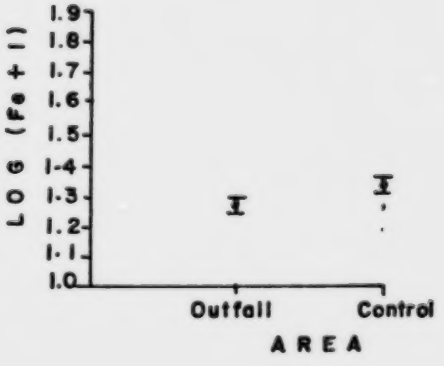
TUKEY'S HSD

Error Mean Square - .0013
Degrees of Freedom - 8
Harmonic Average Sample Size - 3.2000
Alpha Level - .05
Table Value from Studentized Range - 3.26
HSD Value - .0648

MULTIPLE COMPARISONS ON AREA

Area	Mean	Sample Size	Separation
Outfall	2.385264	8	a
Control	2.484997	2	b

FIGURE 7 TUKEY'S MULTIPLE COMPARISON FOR 1985 SEDIMENT ZINC - OUTFALL VERSUS CONTROL



TUKEY'S HSD

Error Mean Square - .0011
Degrees of Freedom - 11
Harmonic Average Sample Size - 4.6154
Alpha Level - .05
Table Value from Studentized Range - 3.11
HSD Value - .0483

MULTIPLE COMPARISONS ON AREA

Area	Mean	Sample Size	Separation
Outfall	1.272462	10	a
Control	1.338285	3	b

FIGURE 8 TUKEY'S MULTIPLE COMPARISON FOR 1985 SEDIMENT IRON - OUTFALL VERSUS CONTROL

compared the mean metal levels for stations CO 1-10 (1979 and 1984) and found only manganese (Mn) and chormium (Cr) had significantly increased between sampling periods. However, their increase was not definitively attributable to the outfall because:

- maximum and minimum concentrations of the elements occurred in the same general area before and after the outfall, and
- sediment metal concentrations were negatively correlated to proximity to the outfall.

When sediment data from stations CO 4 and 5 (Table 6) are pooled and compared between 1979, 1984 and 1985 only sediment volatile residue (SVR) showed a significant change ($p < 0.05$) with 1984 levels higher than either 1979 or 1985 (Table 5).

TABLE 6 SEDIMENT DATA CO-4 AND CO-5, 1979-1985
(mg/kg dry wt. unless otherwise stated)

PARAMETER	STN.	1979	1984	1985	PARAMETER	STN.	1979	1984	1985
COPPER	4a	11.7	13.2	13.9	MERCURY	4a	< 0.099		.084
	4b	12.3	12.4	12.2		4b			.080
	5a	14.3	14.0	13.3		5a			.112
	5b	14.7	10.1	14.2		5b	.271		.093
MANGANESE	4a	243	281	214	IRON	4a	1.83	1.92	1.86
	4b	234	296	232	(% dry	4b	1.87	2.01	1.69
	5a	223	265	242	wt.)	5a	1.75	1.87	1.87
	5b	233	231	300		5b	1.83	1.47	2.06
ZINC	4a	20.0	31.8	23.7	SVR	4a	1.30	3.02	1.37
	4b	20.0	31.1	22.0	(% dry	4b		2.87	1.40
	5a	23.1	31.1	24.1	wt.)	5a	1.70	3.20	1.51
	5b	22.8	24.0	25.1		5b		2.88	1.16
ALUMINUM	4a	1.20	1.20	.97					
(% dry	4b	1.17	2.01	1.02					
wt.)	5a	1.24	1.11	1.17					
	5b	1.27	1.47	1.18					

Sediment volatile residue was statistically higher in June 1984 than November 1979 at all stations (Table 6). However when 1985 data is considered (Figure 9) a clear pattern of higher summer sediment volatile residue is seen at all stations:

	SVR	
1979	< 2 %	(winter)
1984	3 %	(summer)
1985	< 2 %	(winter)

Sediment volatile residue was higher during the summer likely due to increased settlement of phyto- and zooplankton. A similar increase in phytodetritus to sediment has been documented in a controlled nutrient-enriched ecosystem experiment (Parsons, 1984).

In summary, there have been no significant increases in metals or SVR detected at this outfall to date. In addition, values for copper, manganese, zinc and iron are higher at the control site. Thus, no impact of the outfall was detected on those sediment parameters examined after about one year of sewage discharge.

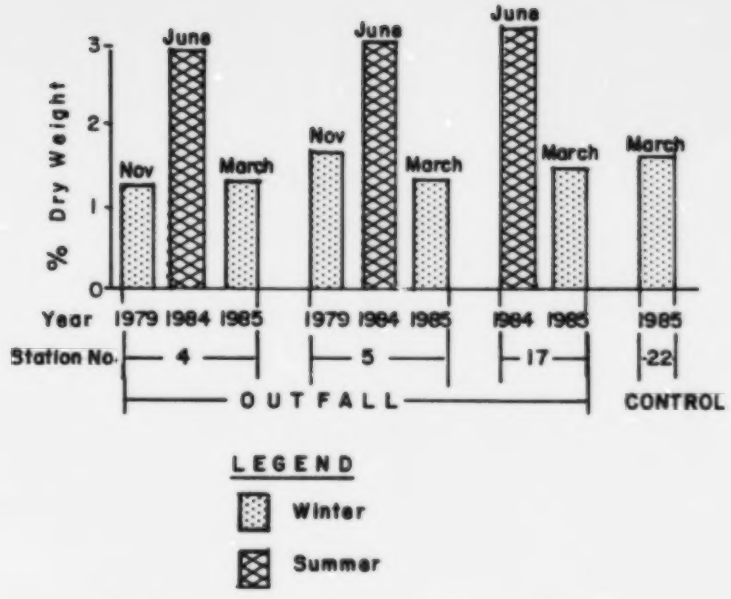


FIGURE 9 SEDIMENT VOLATILE RESIDUE 1979 - 1985
SHOWING SEASONAL FLUCTUATIONS

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APPENDICES

APPENDIX I CAPE LAZO SAMPLING STATION LOCATIONS 11 MARCH 1985

STATION	DEPTH (m)	LOCATION	
		NORTH	WEST
CO-5	63	49 42.33	124 49.26
CO-4	64	49 42.50	124 49.41
CO-17	80	49 42.44	124 48.93
CO-21	64	49 42.09	124 49.09
CO-22	63	49 42.27	124 55.20

APPENDIX II COMPLETE SEDIMENT (ICAP) METAL DATA

ELEMENT	METALS IN SEDIMENT (ug/g) LABORATORY NUMBER AND STATION												
	850199001 CO 4a	850199001 CO 4aa	850199002 CO 4b	850199003 CO 17a	850199004 CO 17b	850199005 CO 21a	850199005 CO 21aa	850199006 CO 21b	850199007 CO 5a	850199008 CO 5b	850199009 CO 22a	850199010 CO 22b	850199010 CO 22bb
AS	< 8.	< 8.	< 8.	< 8.	< 8.	< 8.	< 8.	< 8.	< 8.	< 8.	< 8.	< 8.	< 8.
BA	16.4	15.8	15.7	22.6	19.7	16.4	16.1	18.2	19.3	19.2	18.1	18.1	19.9
BE	< .2	< .2	< .2	< .2	< .2	< .2	< .2	< .2	< .2	< .2	< .2	< .2	< .2
CD	< .3	< .3	< .3	< .3	< .3	< .3	< .3	< .3	< .3	< .3	< .3	< .3	< .3
CO	6.1	7.5	8.3	6.3	6.5	6.	9.8	13.2	7.8	9.5	2.3	11.3	6.8
CR	17.5	17.7	16.8	19.7	18.6	15.7	18.2	18.1	18.4	20.	21.9	18.7	19.3
CU	13.9	13.8	12.2	15.5	13.5	13.1	15.7	12.3	13.3	14.2	15.7	15.9	16.8
MN	214.	215.	232.	307.	283.	244.	250.	267.	242.	300.	371.	300.	313.
MO	< .8	< .8	< .8	< .8	< .8	< .8	< .8	< .8	< .8	< .8	< .8	< .8	< .8
NI	< 3.	< 3.	< 3.	< 3.	< 3.	< 3.	< 3.	< 3.	< 3.	< 3.	< 3.	3.	4.
P	732.	731.	682.	751.	710.	653.	735.	743.	699.	804.	782.	685.	742.
PB	< 3.	< 3.	< 3.	< 3.	< 3.	< 3.	< 3.	< 3.	< 3.	< 3.	< 3.	< 3.	< 3.
SN	< 2.	< 2.	< 2.	< 2.	< 2.	< 2.	< 2.	< 2.	< 2.	< 2.	< 2.	< 2.	< 2.
SR	33.2	32.6	39.	45.5	43.5	34.5	34.3	44.7	44.9	44.4	48.	37.	39.4
TI	1380.	1450.	1650.	2040.	1890.	1450.	1500.	1860.	1930.	1860.	2820.	1980.	2160.
V	72.	74.	69.	82.4	76.3	68.	75.	76.8	77.4	85.	104.	81.	85.
ZN	23.6	23.8	22.	29.1	24.6	22.8	24.7	22.4	24.1	25.1	30.8	29.4	31.2
AL	9710.	9700.	10200.	12200.	11500.	10100.	10300.	11600.	11700.	11800.	13900.	12500.	13100.
FE	18400.	18800.	16900.	20500.	18900.	17200.	18900.	18700.	18700.	20600.	25000.	19900.	20800.
SI	360.	370.	470.	470.	510.	380.	300.	600.	480.	250.	< 20.	200.	40.
CA	9570.	9600.	10200.	11700.	11200.	9440.	9660.	11200.	11700.	11800.	13900.	12500.	13100.
MG	3740.	3750.	3790.	4620.	4250.	3890.	4030.	4190.	4280.	4350.	5240.	4960.	5230.
NA	1950.	1930.	2040.	2610.	2310.	2190.	2330.	2180.	2170.	2260.	2170.	2290.	2450.